



# MS Transitional Refresher Course

## Module 4 Pharmacology



# Sources of Drugs

- **Plant**

- Morphine, heroin, codeine—opium plant
- Atropine—*Atropa belladonna*
- Digoxin—purple foxglove



# Sources of Drugs



- **Animal**
  - Insulin/Oxytocin—  
beef/pork/human
  - Cod-liver oil--Fish

# Sources of Drugs

- **Mineral**
  - Sodium bicarbonate
  - Calcium Chloride
  - Magnesium Sulfate



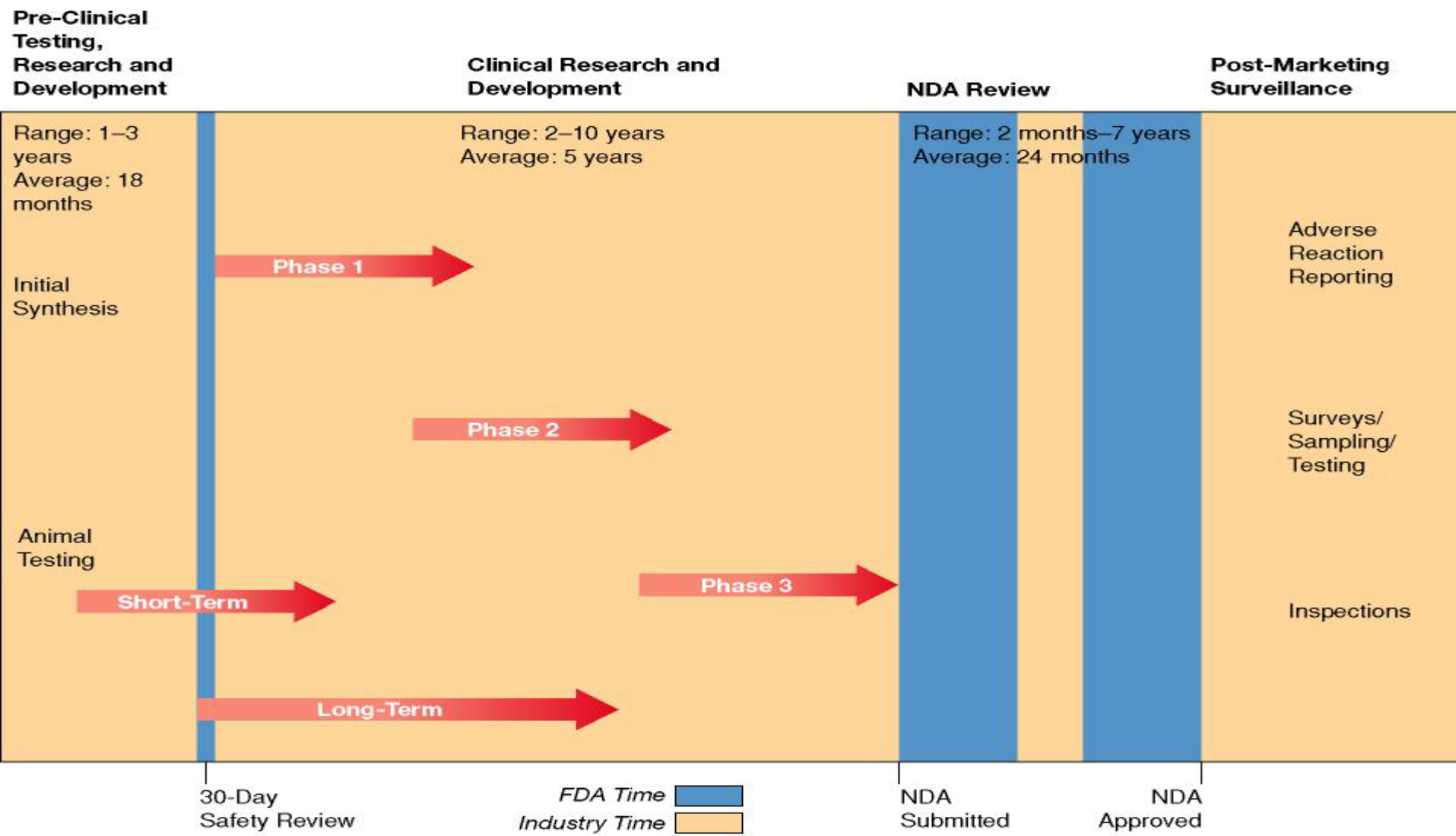
# Sources of Drugs

- **Synthetic**
  - Diazepam
  - Human Insulin



# Bringing New Drugs to Market

## New Drug Development Timeline



# Phases of Human Studies

- Phase 1
  - To determine the drug's pharmacokinetics, toxicity, and safe dose in humans. Limited populations of healthy human volunteers
- Phase 2
  - To determine the therapeutic drug level and watch for toxic side effects. Tested on limited populations of patients who have the disease it is intended to treat.



# Phases of Human Studies (cont)

- Phase 3
  - To refine the usual therapeutic dose and collect data on side effects. Requires a larger patient population. Studies are usually double blind
- Phase 4
  - Involves post-marketing analysis during conditional approval

# FDA Classification of New Drugs

- Utilizes a number and a letter for each new drug
- Numerical Classification (Chemical)
  - Assigned a number 1- 7
- Letter Classification (Treatment or Therapeutic Potential)
- Other Classification

# Laws Affecting Drug Administration

- 1906: Pure Food & Drug Act
  - Enacted to improve the quality and labeling of drugs
  - Established USP and NF as official Standards
- 1914: Harrison Narcotic Act
  - Limited the indiscriminant use of addicting drugs by regulating the importation, manufacture, sale, and use of opium, cocaine, marijuana, and their compounds or derivatives

# Laws Affecting Drug Administration (Cont.)

- 1938: Federal Food, Drug, and Cosmetic Act
  - Empowered the FDA to pre-market safety standards for drugs. Amended in 1951 by the *Durham-Humphrey Amendments* to require written or verbal prescriptions from a physician to dispense certain drugs

# Laws Affecting Drug Administration (Cont.)

- 1970: Comprehensive Drug Abuse Prevention and Control Act
- AKA Controlled Substances Act
  - Classified drugs by abuse potential and medical usefulness.
  - Regulated manufacture, distribution, and sale of controlled substances.
  - Replaced the Harrison Narcotic Act of 1914

# Schedules of Drugs

- Schedule I
  - High abuse potential. No accepted medical indications. (Research use only.)
  - Examples: Heroin, LSD
- Schedule II
  - High abuse potential. Accepted medical indications. Written prescriptions required.
  - Examples: Opium, cocaine, morphine, codeine, oxycodone, methadone

# Schedules of Drugs (cont.)

- Schedule III
  - Less abuse potential than schedule II or II; may lead to moderate or low physical dependence
  - Limited opioid amount or combined with non-controlled substances
  - Examples: Vicodin, Tylenol w/ codeine

# Schedules of Drugs (cont.)

- Schedule IV
  - Low abuse potential compared to schedule III. Limited psychosocial and/or physical dependence
  - Examples: Diazepam, lorazepam, phenobarbital
- Schedule V
  - Lower abuse potential than schedule IV. May lead to psychosocial and/or physical dependence
  - Limited amounts opioids; often for cough or diarrhea



# Drug Profiles

- Components
  - Names
  - Classification
  - Mechanisms of Action
  - Indications
  - Pharmacokinetics
  - Side effects

# Drug Profiles (cont.)

- Routes of Administration
- Contraindications
- Dosage
- How supplied
- Special considerations

# Patient Care with Medications

- Know the Drug profile
- Practice proper technique
- Know how to observe and document effects
- Maintain current knowledge in pharmacology
- Establish and maintain professional relationships with other health care providers

# Patient Care with Medications (cont.)

- Understand pharmacokinetics & pharmacodynamics
- Have current drug references available
- Take careful drug histories
- Evaluate the compliance, dosage, and adverse reactions
- Consult with medical direction when appropriate

# Six Rights of Medication Administration

- Right medication
- Right dose
- Right time
- Right route
- Right patient
- Right documentation

# Special Considerations

- Pediatric Patients
  - Neonates (Infants from birth to 4 weeks) metabolism and excretion may be impaired
  - Children up to one year have diminished plasma protein concentrations. Results in higher free drug availability with drugs that bind to proteins

# Special Considerations

- Many factors cause a pediatrics drug function to differ radically from an adults
- The Broselow tape primarily addresses drugs administered in the critical care setting





# Special Considerations

- Geriatric Patients
  - Common physiological effects of aging
    - Cardiac output
    - Renal function
    - Brain mass
    - Total body water
    - Body fat
    - Serum albumin
    - Respiratory capacity



# Special Considerations

- These changes can lead to:
  - Altered pharmacodynamics & pharmacokinetics
  - Decreased rates of metabolism and excretion
  - Decreased protein binding because of decrease level of serum albumin
- Result – Dosages may have to be decreased
- Elderly also suffer from multiple disease processes
- May be on chronic medications that can affect emergency medications

# Special Considerations

- Pregnant Patients

- Anatomical & Physiological changes



- Increased cardiac output
- Increased heart rate
- Increased blood volume (up to 45%)



- Decreased protein binding
- Decreased hepatic metabolism
- Decreased blood pressure

# Special Considerations

- Drug has the potential to cross the placenta and affect the fetus
- Drug therapy can affect a breast-feeding infant

# Paramedics Responsibilities in Administration of Medications

- Paramedics are personally, legally, morally and ethically responsible for the safe administration of medications
  - Know the precautions and contraindications for all medications you administer
  - Practice proper technique
  - Know how to observe and document drug effects

# Paramedics Responsibilities in Administration of Medications

- Maintain a current knowledge in Pharmacology
- Establish and maintain professional relationships with other health care providers
- Understand the pharmacokinetics and pharmacodynamics
- Have current medication references available

# Paramedics Responsibilities in Administration of Medications

- Take careful drug histories including:
  - Name, strength, and daily dose of prescribed drugs
  - Over-the-counter drugs
  - Vitamins
  - Herbal medications
  - Folk-medicine or folk remedies
  - Allergies
- Evaluate the compliance, dosage, and adverse reactions
- Consult with medical direction when appropriate

# Pharmacokinetics

- Strictly defined, pharmacokinetics is the study of the basic processes that determine the duration and intensity of a drug's effect
- Pharmacokinetic Processes
  - Absorption
  - Distribution
  - Biotransformation
  - Elimination



# Physiology of Transport

- Active transport
  - Requires the use of energy to move a substance
- Carrier-mediated diffusion
  - AKA Facilitated Diffusion
  - Process in which carrier proteins transport large molecules across the cell membrane

# Physiology of Transport (cont.)

- Passive transport
  - Movement of a substance without the use of energy
- Diffusion
  - Movement of solute in a solution from an area of higher concentration to an area of lower concentration

# Physiology of Transport (cont.)

- Osmosis
  - Movement of solute in a solution from an area of lower solute concentration to an area of higher solute concentration
- Filtration
  - Movement of molecules across a membrane from an area of higher pressure to an area of lower pressure.

# Absorption

- The process of movement of a drug from the site of application into the body and into the extra-cellular compartment.

# Absorption

- Affected by many factors including:
  - Solubility of the drug
  - Concentration of the drug
  - pH of the drug/pH of the patient
  - Site of absorption
  - Absorbing surface area
  - Blood supply to the site of absorption

# Distribution

- The process whereby a drug is transported from the site of absorption to the site of action
- Affected by several factors:
  - Cardiovascular function
  - Regional blood flow
  - Drug storage reservoirs

# Distribution (cont.)

- Physiological barriers
  - Blood-brain barrier
  - Placental barrier

# Biotransformation

- A special name for metabolism
- The body's breaking down of chemicals
- Has one of two effects on drugs
  - It can transform the drug into a more or less active metabolite
  - It can make the drug more water soluble (or less lipid soluble) to facilitate elimination



# Biotransformation (cont.)

- Biotransformation takes place in:
  - Liver
  - Kidneys
  - Lungs
  - GI tract

# Biotransformation (cont.)

- First-pass effect
  - Blood supply from the GI Tract passes through the liver before moving on through the systemic circulation.
  - First pass may completely inactivate many drugs
  - These drugs must be given IV rather than orally

# Biotransformation (cont.)

- Biotransformation begins immediately following introduction of the drug
  - Certain drugs are rapidly transformed
  - Epinephrine is active as administered and rapidly metabolized to inactive forms

# Biotransformation (cont.)

- The liver's microsomal enzymes react with drugs in two ways
  - Phase-I (non-synthetic reactions.)
    - Most often oxidize the parent drug
    - May reduce or hydrolyze the drug
  - Phase II (synthetic reactions.)
    - AKA conjugation reactions, combine the pro-drug or its metabolites with an endogenous chemical, usually making the drug more polar and easier to excrete

# Elimination

- Refers to movement of a drug or its metabolites from the tissues back into the circulation and to the organs of excretion
  - Urine Via the Kidneys
  - Bile Via the Liver
  - Feces Via the Intestines
  - Expired air Via the Lungs
  - Sweat, saliva, and breast milk

# Elimination (cont.)

- Eliminated in original form or as metabolites
- Elimination is affected by:
  - Drug half-life
  - Accumulation
  - Clearance

# Onset, Peak, and Duration

- Determined primarily by its bio-availability and drug concentration in the blood

# Drug Routes





# Enteral

- Absorption through the GI tract
- Enteral Routes
  - Oral (PO)
  - Orogastric / nasogastric tube (OG/NG)
  - Sublingual (SL)
  - Buccal
  - Rectal (PR)

# Internal (cont.)

- Advantages
  - Simple; Safe
  - Generally less expensive
  - Low potential for infection
- Disadvantages
  - Slow rate of onset
  - Cannot be given to unconscious or nauseated patients
  - Absorbed dosage may vary significantly

# Parenteral Routes

- Broadly defined, any Route outside of the GI tract
- Parenteral Routes
  - Topical/Intradermal/Subcutaneous
  - Intramuscular/Intravenous/Intraosseous
  - Endotracheal/Sublingual injection/Inhalation
  - Umbilical/Vaginal/Rectal

# Drug Forms

- Solid/Pills/Powders/Tablets
- Suppositories/Capsules/Liquid
- Solutions/Tinctures/Suspensions
- Emulsions/Spirits/Elixirs
- Syrups

# Pharmacodynamics:

Is the study of mechanisms by which specific drug dosages act to produce biochemical or physiological changes in the body

# Actions of Drugs

Medications can act in four different ways

1. Bind to a receptor site
2. Change the physical properties of cells
3. Chemically combine with other substances
4. Alter a normal metabolic pathway

# Actions of Drugs (Cont.)

- Binding To A Receptor Site
  - A receptor is a specialized protein that combines with a drug resulting in a biochemical effect
  - Affinity (Force of attraction between a drug and a receptor )
  - Efficacy (A drugs ability to cause the expected response)

# Actions of Drugs (Cont.)

- Second messenger
  - Chemical that participates in complex cascading reactions that eventually cause a drug's desired effect
- Down-regulation
  - Binding of a drug or hormone to a target cell receptor that causes the number of receptors to decrease



# Actions of Drugs (Cont.)

- Up-regulation
  - A drug causes the formation of more receptors than normal
- Stimulation of A Receptor Site
  - Chemicals that stimulate fall into two broad categories

# Actions of Drugs (cont.)

- Stimulation of A Receptor Site
  - Chemicals that stimulate fall into two broad categories
    - Agonist
      - Causes it to initiate the expected response
    - Antagonist
      - Causes the drug not to initiate the expected response
    - Some drugs do both--Called agonist-antagonist  
AKA Partial agonist

# Stimulation of A Receptor Site

- Competitive antagonism
  - One drug binds to a receptor and causes the expected effect while also blocking another drug from triggering the same receptor
- Non-Competitive antagonism
  - The binding of an antagonist causes a deformity of the binding site that prevents an agonist from fitting and binding

# Stimulation of A Receptor Site

- Irreversible antagonism
  - A competitive antagonist permanently binds with a receptor site

# Other Actions of Drugs

- Changing Physical Properties
  - Osmotic balances across membranes are good examples. (ie: Mannitol)
- Chemically combining with other substances
  - Drugs that participate in chemical reactions that change the chemical nature of their substrates

# Other Actions of Drugs

- Altering a normal metabolic pathway
  - The anticipated product will not form, or, if formed, will be substantially or completely inactive

# Responses to Drug Administration

- Side effect
- Allergic reaction
- Idiosyncrasy
- Tolerance
- Cumulative effect
- Drug dependence
- Potentiation

# Drug Response Relationship

- Correlates different amounts of drug to the resultant clinical response
- Plasma-level profile
  - Describes the lengths of onset, duration, and termination of action, as well as the drug's minimum effective concentration and toxic levels



# Drug Response Relationship (cont.)

- Factors Altering Drug Response
  - Age
  - Body Mass
  - Sex
  - Environment
  - Time of Administration
  - Pathologic state
  - Genetic factors
  - Psychological factors

# Drug Interactions

- Variables that may cause drug-drug interactions
  - One drug could alter the rate of intestinal absorption.
  - The two drugs could compete for plasma protein binding, resulting in one's accumulation at the other's expense

# Drug Interactions

- One drug could alter the other's metabolism, thus increasing or decreasing either's bioavailability.
- One drug's action at a receptor site may be antagonistic or synergistic to another's.
- One drug could alter the other's rate of excretion through the kidneys

# Drug Interactions

- One drug could alter the balance of electrolytes necessary for the other drug's expected result

The background of the slide is a dark blue-tinted photograph of an ambulance. The ambulance is white with blue and red accents. The number 'A25' is visible on the side, and '911' is on the rear. The text 'ADMINISTRATIVE' is partially visible on the side. The ambulance is parked on a street.

# **Administering medications through a gastric tube**

# Indications

- Patients who have difficulty swallowing or nutritional status is poor

# Equipment

- A 100 ml Cone-tipped syringe
- A 30-50 ml Cone-tipped syringe for medication.
- 50-100 ml of Normal Saline

# Technique

Confirm proper tube placement.





Withdraw the plunger while observing for the presence of gastric fluid or contents.



Instill the medication into the gastric tube.



Gently inject the saline.



Clamp off the distal tube.



# Precautions

- Avoid administering time released medications
  - Crushing of medication destroys its slow release mechanism



# Administering medications rectally

- Drugs given rectally do not pass through the liver and therefore do not undergo hepatic alteration (first pass effect)

# Technique

- Confirm the indication for administration and dose, and draw the correct quantity of medication into a syringe.
- Place the hub of a 14-gauge Teflon catheter (removed from the angiocatheter) on the end of a needleless syringe.

## Technique (cont.)

- Insert the Teflon catheter into the patient's rectum and inject the medication in the lower part of the rectum. Administration higher in the rectum may result in the medication's being absorbed by veins that deliver the drug to the portal circulation.



# Technique (cont.)

- Withdraw the catheter and hold the patient's buttocks together thus permitting retention and absorption

Catheter placement on needleless syringe.



Syringe attached to endotracheal tube.




# Prepackaged enema container.



The background of the slide is a solid blue color. On the left side, there is a vertical orange bar. Faintly visible in the background is a white medical waste truck with a blue stripe and the number 'A25' on its side.

# **Disposal of contaminated sharps**



Preparedness is the key to proper  
disposal of sharps in the pre-  
hospital environment

# Preparedness

- Have a small sharps container in your jump kit or drug box.
- Make sure all sharps container on ambulance and kit are not filled and lids are in good working condition.
- Properly close and replace any sharps containers needing to be changed

# Preparedness (cont.)

- Sharps disposal must be completed immediately after administering medication
  - Never lay sharps on the ground or stick them into the ground.
  - Never stick sharps into the bench seat or any other surface in the ambulance



# Preparedness (cont.)

- Needle handling precautions
  - Minimize task in a moving ambulance.
  - Properly dispose of all sharps
  - Recap needles only as a last resort